Capital and Risk and their Relationship to Reinsurance Programmes

by Stewart M. Coutts and
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Abstract
An earlier paper by the same authors developed the Daykin *et al.* (1994) asset/liability model to examine the effects of different reinsurance programmes on the capital of a direct property/casualty insurance company. By modelling the gross premiums and claims separately from the impact of reinsurance on them, it is possible to examine directly the effects of different reinsurance programmes on a company's expected performance just as easily as changes in asset mix or business volumes.

This paper goes on to discuss how such a model can be used to quantify capital at risk for management reporting purposes, both for the company as a whole, and within individual profit centres, and how this is affected by different reinsurance strategies. It therefore links closely to the Dynamic Financial Analysis project being sponsored by the Casualty Actuarial Society.

Biographies
Dr Stewart Coutts is a consulting actuary, who has specialised in property/casualty insurance for 25 years. He published papers on the rating of motor insurance in the early 1970's, and was a member of the British Solvency Working Party in the mid-1980's. The work done by this body was a forerunner of both the Daykin model and the NAIC Risk Based Capital model.

Tim Thomas is a Chartered Accountant, who has worked in various capacities in the insurance industry for over 20 years. He joined the reinsurance division of Willis Faber & Dumas as an executive director four years ago, and since then has been involved in various aspects of alternative risk transfer, as well as being involved in the Group's market security operations. He has a degree in Mathematics from Southampton University.

1. Introduction

1.1 Insurance companies have as their prime business the accepting of unwanted risk on behalf of others. They accept different types of risk in the expectation of being able to generate an adequate return on capital from the premiums charged. The management of the risk so assumed within the company is therefore of fundamental importance to the success of the operation.

1.2 Intuitively, an insurance company ought to be able to manage exposures of both liabilities and assets in such a way that it allocates its established "risk tolerance" between underwriting activities and investment strategy to maximise its expected overall return on capital. By this, we mean the management's willingness to live with unstable results in order to boost expected profitability. The "risk tolerance" level of an individual company is clearly a matter for its Board of Directors to establish, subject to regulatory minimum standards.

1.3 By expressing this "Company Standard" level in financial terms, it becomes possible to measure the amount of capital at risk in both the company as a whole, and in individual operating units. The company's performance can then be measured and managed, and different business strategies can be compared - a task ideally suited to stochastic modelling.

1.4 In order to improve return on capital, either in an individual profit centre or in the company as a whole, we can either increase profits or reduce capital employed. This paper addresses in particular the quantification of capital employed, and how this is affected by different reinsurance strategies.

1.5 Reinsurance has traditionally been bought to stabilise both profits and capital of an insurance company. It therefore has a major impact on the risk capital requirements of both the company as a whole, and each individual unit. If we want to manage risk capital, we have to be able to understand how reinsurance affects it.

1.6 We consider that a better understanding of the overall financial impact of reinsurance is of increasing importance because of the need to compare the relative merits of different reinsurance structures both with each other, and with the range of new capital market solutions being developed, which offer varying degrees of risk transfer.

2. Capital at risk *v* RBC

2.1 The risks to which the insurance company are subject can affect a company's balance sheet in different ways. The RBC model introduced recently in the USA is an attempt to quantify the overall effect of these risks, and set appropriate minimum capital standards.

2.2 In this paper, we differentiate between the values given by applying this model, and management's own internal quantification of capital at risk. To avoid confusion, we use the term "RBC" as the value determined by the NAIC RBC model, and "capital at risk" as the internal measure. In no way are we seeking to question the value of the RBC formula itself, both as a regulatory tool, and as a device for educating management as to the value of using quantative techniques to review the effectiveness of their strategies for maximising prudent returns.

2.3 The RBC model is designed to serve as a diagnostic tool for regulators, primarily as an early warning indicator of situations which may need regulatory attention. However, it is likely that companies with high scores will try to capitalise on them by encouraging the creation of "league tables", which in turn will trigger a flight to perceived quality.

2.4 It is therefore likely that companies, particularly those with lower than average RBC positions, will take action to improve their situations. Some of this action will undoubtedly be of a cosmetic nature, similar to the "financial reinsurance" abuses which FAS113 has tried to outlaw. Other action will undoubtedly be taken for sound business reasons. In any case, RBC implications will increasingly be taken into account by managements in formulating their strategic plans.

2.5 As managements become increasingly aware of the impact of RBC requirements on business, there will be an increasing realisation of the need to service capital. Thus managements now have a growing need for a tool for allocating capital to, and measurement of performance of, individual operating units.

3. RBC Formulae *v* Stochastic Asset/Liability Modelling

3.1 The authors see RBC formulae as as a regulatory tool, rather than for use inside a company, either for risk management or capital allocation purposes. From this perspective, there are a number of weaknesses, in particular

- they look back at where the company has come from, rather than attempting to factor in future business plans
- the company's exposure to catastrophic loss is considered neither gross nor net of reinsurance
- reinsurance factors are based on past average experience and no explicit allowance is made for changing future reinsurance programmes

3.2 Further, a model built along RBC lines involves the setting of various parameters for each class of business, which tend to be based on market average data. In theory, it would be possible to adjust these market figures for internal management purposes, and to assess the effect of different reinsurance arrangements. However, these adjusted parameters would need to be established and justified to management at both corporate and profit centre levels.

3.3 On the other hand, stochastic asset/liability modelling goes back to first principles to generate estimates of each individual cash flow for each line of business. By modelling the gross premiums and claims separately from the impact of reinsurance on them, it is possible to examine directly the effects of different reinsurance programmes on a company's expected performance just as easily as changes in asset mix or business volumes.

4. What is a Stochastic Model?

4.1 Our earlier paper to the Institute of Actuaries in February 1997(Coutts and Thomas (1997)) described the WISPR stochastic asset/liability model, able to simulate the major types of reinsurance treaty. This model is designed to simulate the development of both assets and liabilities of an insurance company which accepts new business for a period of three years, projecting forward until all outstanding claims have been paid. The three year planning horizon was set as a compromise between the desire to establish a medium term view of the company's development, and the difficulty of setting realistic input assumptions.

4.2 In this paper, we show how the output from this model can be developed as a means of allocating risk capital by profit centre, taking fully into account the different risk profiles of different classes of business, and how this process is influenced by different reinsurance structures. The model itself is described more fully in our first paper, but for convenience, the overall design is summarised in Appendix 1.

4.3 Stochastic model office systems, based on forecasting individual cash flows from each line of business, have been well-established in the Life Insurance industry for several years, and are still in their infancy in Property/Casualty insurance. They will grow in importance as their sophistication grows. They need to be driven from the top of an organisation as an integral part of the planning process, and require constant amendment and refinement. Their use gives a totally new dimension to management information, not a replacement for previous reports, but extra leverage from there.

4.4 By modelling each cash flow separately, the anticipated results arising from different strategies can be compared, and in particular the inter-relationship between investment risk and insurance risk can be managed. These models allow management to:-

- Establish the risk profile of the company in financial terms
- Understand and manage the volatility in earnings
- Compare alternative strategies on a level playing field
- Allocate risk capital by line of business, and set profit targets
- Examine the relative merits of different reinsurance structures

5. Why buy reinsurance?

5.1 Apart from certain non-financial considerations, such as the acquisition of technical assistance from reinsurers, the traditional reasons for buying reinsurance are:-

- To protect capital
- To stabilise earnings
- To release capital for alternative uses

5.2 These reasons translate easily into the new language of maximising return on capital at risk. What has happened is the growth of alternative risk transfer mechanisms, and the extra sophistication of capital markets. The range of options open to management now includes:-

- Traditional bond and equity finance
- "Act of God" bonds
- Reinsurance derivatives
- Financial or Finite Risk reinsurance
- Reinsurance captives
- Traditional reinsurance

5.3 Reinsurance has long been held to be a substitute for capital, but little work has been published as to how this can be measured. With the growing interest of capital markets in risk transfer products, this measurement will become critical, so that comparisons can be made into the cost-effectiveness of different instruments. In particular, for management to assess the effect of a particular reinsurance contract as compared to alternative strategies, management needs to measure:-

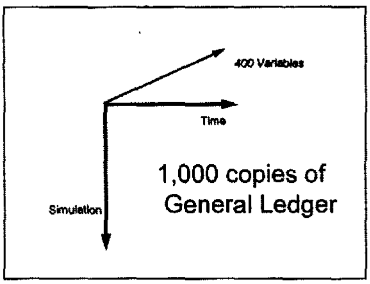
- how much capital is released by the reinsurance contract
- how much it costs to service
- over what time-scale the capital has to be repaid.

6. The main outputs from WISPR

6.1 When we built the model, we recognised that the outputs needed to be able to be interpreted by a wide range of people within the management team,including actuaries, underwriting managers, investment managers and non-executive directors. We therefore considered it essential to produce these outputs as easily understood graphs as far as possible, leaving the numeric values they summarised to be used for more detailed analysis by the appropriate specialists.

6.2 In order to generate all the cash flows, the model builds up for each simulation in each run, a summary of the company's general ledger from last year-end until the run off of the last claim from business accepted in three year's time.

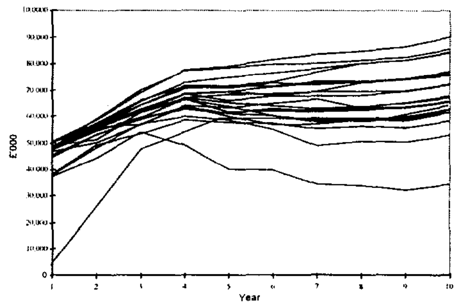
Figure 1. Outputs of each run



6.3 The output consists of values of a large number of variables (approx 400), each of which is indexed by a simulation number and projection year. This produces an enormous amount of data and we had to use a database package to manipulate it. The importance of keeping all the simulated data cannot be emphasised enough because this allows the database to be interrogated to identify which particular simulation run is giving odd results and why. Strategies can then be developed to overcome this problem.

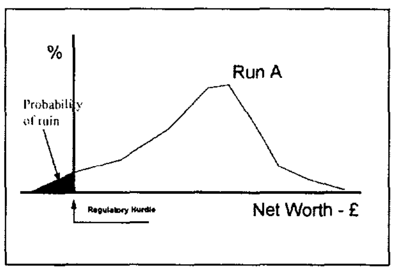
6.4 The graph below plots twenty simulations of the net worth (policyholder surplus) of the company over the ten year period from the last balance sheet until all claims from projection year three have been paid. Each line represents one simulation. There is considerable variation in result in the first four years, but results stabilise after the company enters runoff. In practice, of course, considerably more than twenty simulations would be made, but in this paper we have limited the number in order to produce clearer pictures!

Figure 2. Development of Net Worth



6.5 Alternatively, we can look at the net worth at a point in time. This is done by plotting the probability distribution of the simulation output at a fixed time, for example at the end of three years.

Figure 3. Probability Distribution of Net Worth at the end of 3 years



6.6 We believe this graph gives a very easily understood picture of the volatility of performance. Management should be trying to shift the graph as far to the right as possible, representing an increase in profits, whilst keeping it as peaked as possible, thus stabilising the profits. The left hand side shows the probability of failing to meet the chosen yardstick. The "regulatory hurdle" axis can be drawn in various places to indicate either internal or external requirements, whilst the "probability of ruin" is the probability of failing to meet this yardstick, at a fixed point of time.

6.7 Once this first run has been completed (a major task comparable to, and probably done in conjunction with, the annual budgeting process), other runs (different reinsurance programmes or different asset-mixes etc.) can be carried out, and the results compared, thus allowing a picture to be built up comparing the risks and returns expected from following different strategies. We can apply this technique to the particular case of looking at the impact of different reinsurance structures on capital at risk.

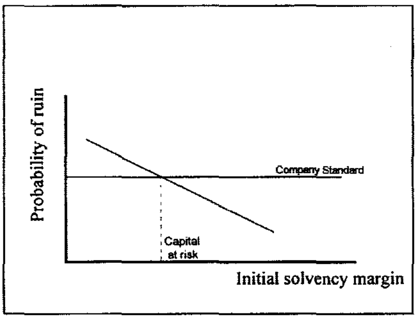
7. Capital Allocation by line of business

7.1Once each line of business has been fitted to the model, we can use this output to allocate risk capital to each line of business, and to assess how this is impacted by different reinsurance structures.

7.2 Management first needs to set its limit of risk tolerance, possibly as a maximum acceptable probability of ruin of, say, one in 100 years for the company as a whole, or, more likely, a probability of failure to meet a specifed multiple of regulatory requirement. A lower hurdle can then be established for an individual profit centre.

7.3 The model can now be run for a single profit centre within the company, to establish the capitalisation required to meet this ruin probability hurdle.

Figure 4. Set Company Standard for Probability of Ruin



7.4 Figure 3 showed the probability of ruin for a particular scenario. By altering the initial capital, leaving all other inputs unchanged, it is possible to build up a plot of the probability of ruin measured against the opening capital. Figure 4 shows this latter graph for a particular profit centre, and the capital at risk can be established by comparison against the company standard.

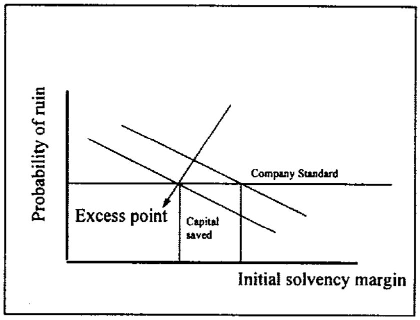
8. Comparison of different reinsurance structures

In paragraph 5.3 above, we identified three questions to address:

8.1 How much capital does a reinsurance contract release?

8.1.1 We can run the model twice, once with each programme, and plot the probability of ruin against initial solvency margin for both runs. Applying the company minimum standard to these gives the following pictorial results for two different excess of loss reinsurance programmes:-

Figure 5. Measure capital saved

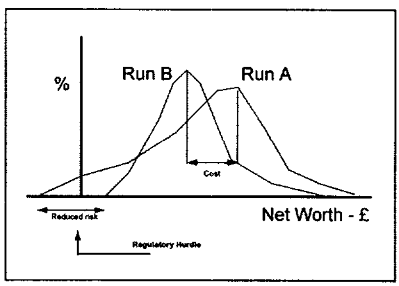


8.1.2 Figure 5 shows the risk capital saved by reducing the excess point at a predetermined probability of ruin. This capital saved can now be used for alternative purposes within the company.

8.2 How much does this cost to service?

8.2.1 The servicing cost of the extra reinsurance is the premium paid away, less the anticipated recoveries, taking into account any lost investment income. This can be examined by comparing the probability distributions.

Figure 6. Expected servicing cost



8.2.2 Figure 6 shows the net worth of a company at the end of the period. Run A is the present reinsurance arrangement and Run B is a different one. The difference between Run A and Run B is that Run B is safer but has a lower expected return than Run A. But the price the company pays under Run A is a higher probability of ruin.

8.3. Over what timescale does the capital have to be repaid?

8.3.1 This last point is the fundamental difference between reinsurance and borrowing. Traditional reinsurance tends to be renegotiated annually, but with the expectation of long term continuity. In particular, there is no contractual obligation for losses to be repaid, although a deficit usually leads to a price increase, and continued deficits to a cancellation of cover.

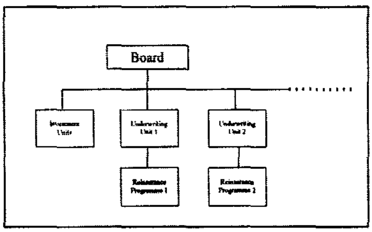
9. Company re-structuring

9.1 In spite of several weaknesses, the RBC formula approach has led to management having a far greater incentive to look at risk management and capital allocation. Perhaps, therefore, the greatest contribution comes from forcing management to impose proper controls on capital allocation.

9.2 It should be noted that in order to make this process fully effective, there will need to be much closer liaison between line insurance managers and the Treasury function than has often been the case, and indeed this trend has already started with Chief Financial Officers taking a growing interest in reinsurance purchasing decisions.

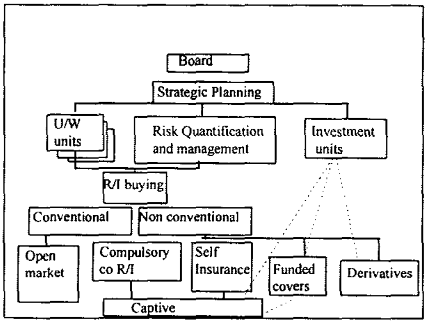
9.3 In order to achieve this, we believe the present management structure, as shown in Figure 7, has to be altered.

Figure 7. Present insurance company



9.4 In this structure, each underwriting unit has its own management team working independently, and having its own separate reinsurance arrangement. Taking company-wide decisions on risk management, or integrating investment policy with underwriting exposure is almost impossible to achieve. Therefore we believe a change is inevitable towards:-

Figure 8. New insurance company



9.5 Figure 8 shows what we believe will be the structure of the new insurance company. The reinsurance element has been promoted to be almost equal in importance to investments. Further, reinsurance requirements will be decided by looking at the corporate level as part of the overall risk management, rather then at a line of business level. Hence, the decision process between choosing reinsurance or capital becomes much closer in the management thinking.

9.6 Strategy is determined through a central "Risk Quantification and Management Committee" with individual companies expected to make say 10% after tax, and individual product lines 5% after tax return on risk adjusted capital - including risk-free investment return on reserves. The investment unit "borrows" from underwriting departments risk free, and has to earn the remaining5% after tax

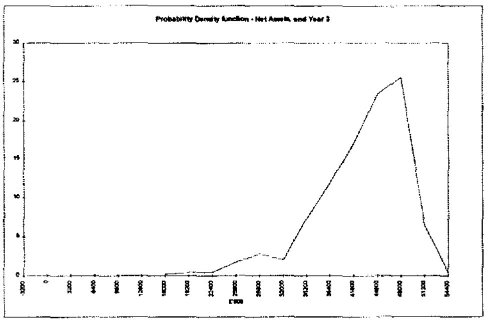
10. A comparison of Capital at Risk and RBC

10.1 This paper sets out a case for using the output from a fitted stochastic model to allocate capital by line of business, and to measure the impact of different reinsurance programmes on this capital requirement. But does it work in practice?

10.2 In our earlier paper, we gave a simple illustration of how the model could be used for a start-up monoline company, writing UK homeowners business. The company had an initial capital of £50 million, and writes an annual premium of £100 million. This line of business is exposed to catastrophe accumulations for both windstorm and flood, and therefore requires significant reinsurance protection. (Typically, a rerun of the 90A UK windstorm of January ,1990 would be expected to give a loss of around £40m, whilst the 1953 North Sea Tidal Surge floods would produce a loss of £90m plus.) The detailed assumptions for this illustration are shown in Appendix 2.

10.3 The first run of the model, with a catastrophe reinsurance programme of £80million excess of £10million, 95% placed, produced the individual plots of net worth previously shown in Figure 2. By taking a cross section through all 1,000 simulations at the end of Year 3, we produced the following distribution of net worth (Figure 9):-

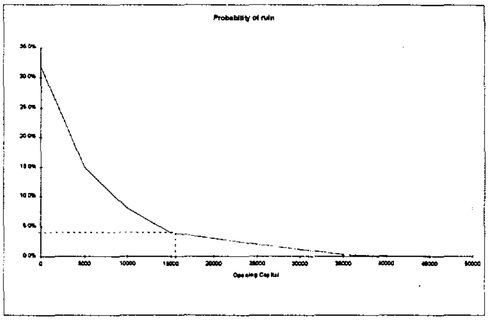
Figure 9. Demo Insurance Co. Net Worth - Run 1



10.4 It is worth noting in passing that although all the detailed assumptions used are for illustration purposes only, the answers being produced by the model reflect the unstable nature of the results of a mono-line company writing catastrophe-exposed business.

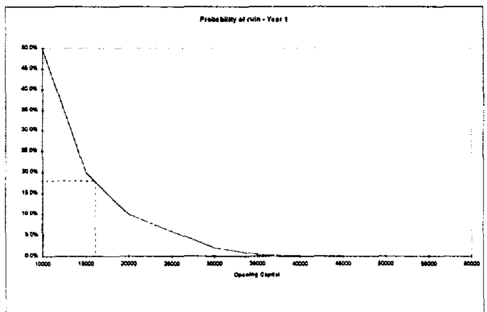
10.5 We now develop the output further to consider whether the initial capital is fully at risk, and indeed whether a lower figure could be justified (regulatory issues permitting!). We do this by plotting the probability of ruin, as explained in Section 7 above.

Figure 10 Demo Insurance Co - Probability of ruin -Run 1



10.6 Figure 10 shows that at the European Union solvency margin requirement of £16 million, there appears to be approximately a 4% probability of failure, defined as negative net worth at the end of Year 3. However, the start-up company has a very strong probability of making a loss in the first year, as can be seen from Figure 2, and at this £16 million initial capital, the probability of negative net worth at the end of the first year is approximately 19%. (Figure 11.)

Figure 11- Demo Insurance Co - Probability of ruin - Year 1

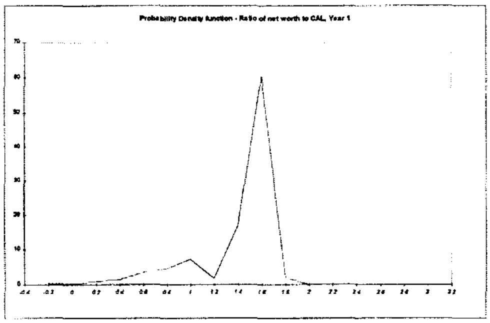


10.7 Not surprisingly, therefore, the UK Department of Trade & Industry (DTI) looks for a level significantly higher than this minimum figure when considering the business plan of a new company. At double the minimum figure, the probability of ruin drops to 1% at the end of Year 1, whilst there is an 18% chance the company will fail the minimum solvency test.

10.8 We can now assume that management's risk tolerance can be expressed as "not allowing the probability of failing the DTI solvency test to fall below 20%.", and re-run the model with an initial risk capital of £32 million. We can then estimate the

RBC requirement for the company at the end of both Years 1 and 3, assuming the same factors are appropriate for both US and UK homeowners business, and that UK Government securities require no risk factor. At the end of Year 1, this gives an RBC requirement of £16.4 million, against average total adjusted capital of £21.3 million. (see workings in Appendix 3), a ratio of 130%, with a standard deviation of 34%, but with a very skew distribution:-

Figure 12 Probability Distribution of RBC %

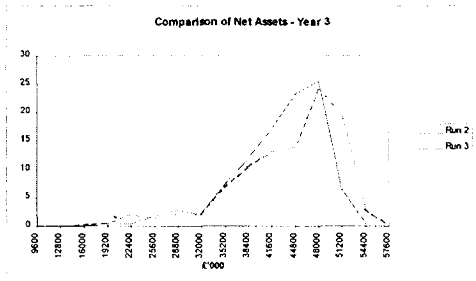


Interestingly, whether by design or coincidence, there is also a 20% chance of breaching the Company Action Level of the RBC rules. (By Year 3, that this ratio has improved to 247%, with a standard deviation of 47%.)

10.9 We can demonstrate from the detailed outputs that reducing the initial capital from £50 million to £32 million increases the 3-year average post tax return on capital from 7.6% to 9%. Not surprisingly, the standard deviation of this return also increases, from 4.6% to 7.8%.

10.10 A risk-averse owner may well be interested in reducing this volatility of earnings by reducing the catastrophe retention to around £6 million. Running the model on this assumption produces a post tax return on capital of 8.46%, with a standard deviation of 6.04%. Alternatively, buying this extra layer reduces the capital at risk from £32 million to £30 million whilst the average reduction in annual post tax profits is £ 0.3 million, equivalent to a 15% post tax servicing cost on the £2million saving.

Figure 13 Comparison of Net Assets at the end of Year 3.



10.11 Management can now decide whether they can use this £2 million released capital more effectivly elsewhere, bearing in mind its servicing cost, and the decrease in volatility in earnings.

11. Conclusion

11.1 We believe that Boards of Directors of insurance companies need a better understanding of the financial risks being assumed by their companies, and how reinsurance arrangements reduce these to manageable proportions. Although tools like WISPR take considerable effort to install, the benefits are substantial, and the timing is now right, with:-

- Increased attention on capital from rating agencies and regulators
- Lower profit margins
- Increase in interest sensitive products
- Increase in market volatility
- Increase in non-traditional competitors

11.2 Inevitably, such benefits can only be obtained at the cost of fitting far more complicated assumptions than are necessary to fit an RBC model.

11.3 By using stochastic modelling to establish estimates of means and variances, it is possible to take assumptions built up by underwriters, using concepts with which they are familiar, and translate these into the language of investment portfolio management. This reduces the gap in understanding across different disciplines at senior management level, and allows comparisons of reinsurance with other forms of risk transfer.

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A description of the WISPR stochastic model

Appendix 1

1. Overview

1.1. The model is designed to simulate the development of both assets and liabilities of an insurance company. This company is assumed to accept new business for a period of three years, and then projects until all outstanding claims have been paid. The three year planning horizon was set as a compromise between the desire to establish a medium term view of the company's development, and the difficulty of setting realistic input assumptions.

1.2. The assets are sub-divided by major categories such as Government stocks, Equities and Property. The models used project forward income cash flows until the claims have runoff or the company is ruined.

1.3. The liabilities work on a class-by-class basis (see section 2), modelling the claim payment cash flows of gross reinsurance results and their associated reinsurance recoveries and reinstatement premiums, after allowing for the effects of both financial and social inflation.

1.4. The reinsurance programme can comprise any combination of four main types, quota share, surplus, risk excess and catastrophe excess. The model can accommodate variable co-reinsurance of each cover, as well as factors such as event caps on proportional treaties. The catastrophe module allows information from GIS (Geographic Information Systems) models to be incorporated for storm, freeze, flood, earthquake and subsidence.

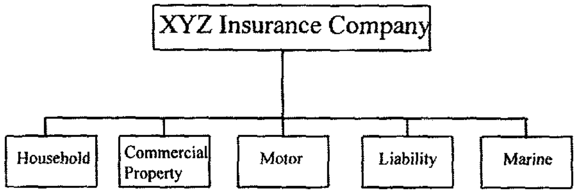
1.5. By combining the cash flows of assets and liabilities the model produces, the potential for profits or losses to emerge from the runoff of outstanding claims.

6. Each run consists of a user-specified number of Monte Carlo simulations, in each of which the variables are sampled from appropriate probability distributions, so that a probability distribution can be built up for the results of the company as a whole. The run can then be repeated with different assumptions, to examine the sensitivity of these results to changing circumstances.

2. Class and subclass structure

2.1 The model calculates gross of reinsurance transactions on a sub-class basis, whilst reinsurance transactions are at a class level (Figure A1).

Figure A1. Tree structure for group, company, class and subclass



2.2 Figure A1 shows a typical division of class and subclass of an insurance company .The main classes of business being household, motor, etc., with motor being split into subclasses Comprehensive and Third Party. The amount of detail at subclass level is company dependent , for example if a company is writing only two classes of business, homeowners and motor, it might be necessary to have three or four subclasses for each class.

2.3 We believe that in practice, the number of classes should be limited to six, and subclasses to no more than ten, so that the overall picture can still be seen without being lost in a mass of detail.

2.4 The class structure will vary from company, and it is essential to determine this before too much time is spent in trying to assemble input data.

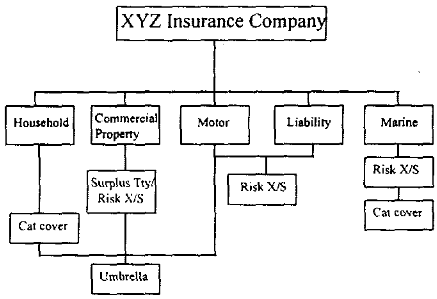
3. The main types of reinsurance

3.1 Reinsurance can be broken down into facultative (laying off parts of individual risks) and treaty (laying off risks aggregated over a block of business). Treaty reinsurance can be further analysed into proportional (principally quota share and surplus) and non-proportional (excess of loss on either a per risk or per event basis, or stop loss). To model reinsurances other than quota share treaties, it is necessary to generate both individual claims and event catastrophes (which is where claims aggregate across several policies to produce a potential recovery). Further, in the case of surplus treaties, commonly used to protect commercial property portfolios, it is necessary to determine the size of cession on each policy subject to a large claim, before a recovery can be calculated.

3.2 There is a bad debt risk involved in ceding business to any reinsurer, however much care is taken in selection, and this can never be entirely removed. Whilst management should not lose sight of this risk, we have ignored it in this paper for simplicity. The model itself can handle the failure of a fixed percentage of security, specified separately for each separate contract, but a more rigorous treatment is worthy of a detailed study.

3.3 We expect a reinsurance programme for the classes of business in Figure A2 to resemble:

Figure A2. Simple reinsurance programme

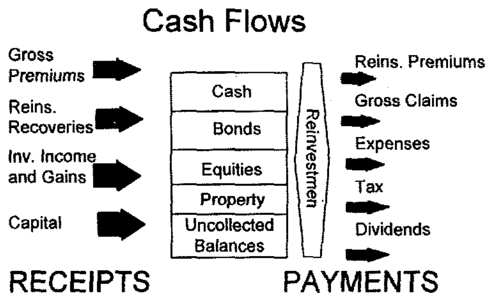


3.4 Figure A2 shows that the household business is protected by a catastrophe, whilst motor and liability are covered by risk excess of loss. Commercial property is protected by a combination of surplus treaty and risk excess. An umbrella whole account protection covers catastrophe accumulation over household, commercial property and motor.

4. Build up cash flows by class of business

4.1 The concept of cash flow modelling is now well documented, for example Daykin et al. (1994) (Chapter 1). In a simple diagram, Figure A3 illustrates the standard cash flows which have to be modelled.

Figure A3. Cash flow



4.2 Alternatively Figure A3 can be linked together in the Daykin et al. (1994) transition equation:-

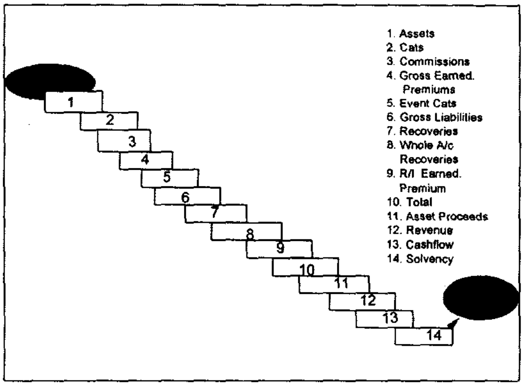
Assets(end of period) = Assets(beginning) +(Gross Premium - Claims - Expenses - Reinsurance Premiums + Reinsurance Recoveries) + Investment income & gains - Taxation - Dividends + New Capital [+ New borrowings].

4.3 With suitable adjustments for changes in provisions, or receivables, this equation can be interpreted on either a cash basis or on an accounting accruals basis.

5.Modular Approach gives flexibility

5.1 The cash flow computer programmes have to be designed very carefully, in particular the main problems relate to inter-relationships between transactions and that actuarial art in projecting forward is always improving. With this in mind, the model was built up in a modular fashion, see Figure A4.

Figure A4. Modular structure



5.2 There are five distinctive stages in building up the final output:

Stage 1 : the data base input

Stage 2: modules 1 and 2 which calculate inflation rates and investment returns and individual catastrophe losses

Stage 3: modules 3, 4, 5, 6 which are defined for each sub-class, calculate cashflows and technical reserves gross of reinsurance

Stage 4 : modules 7, 8, 9 which are reinsurance recovery calculations

Stage 5: modules 11,12,13,14 which are the basis for the outputs .

5.3 By building up the model in modules as shown above, we have attempted to create a flexible structure which will enable changes in the computer program to be made with the minimum of effort. For example, these changes could take the form of a more sophisticated asset model, advances in actuarial techniques, the specification of a different family of claims curves, etc. This flexible approach has also been adopted in relation to links to other models - for example, we have not attempted to duplicate packages for reserving, or for turning claims data into probability distributions.

Assumptions for the demonstration of a simple start-up company

Appendix 2

A detailed list of the parameters used in the simulations of the simple start-up company are given below:

- Initial capital £50 m.

- Opening investment portfolio:

Government Bonds	£45 m
Cash	£3 m
Working Capital	£2 m

- Positive cash flows invested 50% in Government Bonds, 50% in equities.

- Selling Rules

  There are two alternative strategies for how a negative cash flow will affect disinvestment. Firstly, to disinvest in proportion to asset holdings at the start of the year or secondly, the assets are ordered and the asset with the highest priority is sold first. For the start-up company we use the first method.

- The investment assumptions were as follows:-

	Cash	***Equities***	***Bonds***
Mean Real Return	1%	5%	3%
Running Yield	4.5%	3.0%	6.5%
Volatility of Capital Growth		20%	10%
Volatility of Income Growth		5%	1%

- The effective tax rate is 33%, and dividends will be at 50% of after-tax profits.

- Financial inflation was assumed to be normally distributed with a mean of 3.5% and a standard deviation of 0.5%.

- The average rate of financial inflation assumed in calculating the value of mean loss ratios was also assumed to be 3.5%.

- The business plan assumed that in each of the three years of the modelling period, the gross premium was £100 m, and that losses other than catastrophe ones were normally distributed with a mean loss ratio of 55% and standard deviation of 2%. This information could be estimated from competitors' published figures, or other sources. Claims reserves are not discounted.

- The unearned premium carried forward at the end of each year was assumed to be 40%

- Commissions and office expenses were assumed to be 28% of premiums, reducing to 1% of year 3 gross written premium once business is no longer being written.

- Social inflation can be applied at differential rates for attrition and large losses but was ignored in this case.

- Claims runoff patterns - the mean proportion and standard deviation of a claim paid in year *i* of development of the claim. These values are needed for past, future and catastrophe knock-on claims. These are all assumed to follow the same pattern:

Year	*Runoff Pattern*	*Standard Deviation*
1	64	5
2	28	3
3	4	3
4	2	2
5	1	2
6	1	2

- The catastrophe reinsurance programme was structured as follows:-

Layer	*Indemnity*	*Deductible*	*Rate on line*	*Co-reinsurance*
1	10 m	10 m	20%	5%
2	20 m	20 m	12%	5%
3	20 m	40 m	8%	5%
4	30 m	60 m	4%	5%

- The delay (in months) between making gross payments in respect of past and future claims and receiving the recovery payments. For the start-up company these values are taken as 3 months for quota share and 1 month for excess of loss.

- Because the account is not subject to any wide fluctuations in size of sum insured, no reinsurance of individual risks is necessary, and therefore this run of the model did not need to generate individual large losses other than for catastrophes.

- Natural perils catastrophe losses - these can be input either as a series of specific large losses or sampled by the model from a probability distribution. Under this, WISPR requires certain assumptions regarding the probability and potential size of each event for each peril to be input. These assumptions, obtained either from a GIS type model or from general management views, comprise the estimated maximum loss, the probability of an event of at least one tenth this size happening and a table setting out the relative probabilities of the size of the loss, given that one has happened. This table needs to be completed for each decimal of PML. For the start-up company the tables assumed are as follows:

	Claim Size	Probability
Storm	8000	0.42
PML £80,000	16000	0.20
Probability 20%	24000	0.12
	32000	0.07
	40000	0.05
	48000	0.04
	56000	0.03
	64000	0.03
	72000	0.02
	80000	0.02
Flood	10000	0.05
PML £100,000	20000	0.05
Probability 2%	30000	0.05
	40000	0.15
	50000	0.15
	60000	0.15
	70000	0.2
	80000	0.1
	90000	0.05
	100000	0.05

Estimate of Risk Based Capital requirement - Run 2

Appendix 3

This simplified calculation of the Company Action level RBC requirement at the end of Year 1 is based on the requirements as set out in the NAIC instructions for 31st December 1996. These are set out in detail for simulation 3 of run 2, and average figures are also shown for each heading. A revenue account for simulation 3 is included for reference.

R0 Asset Risk - Subsidiary Insurance Companies

Not applicable

R1 Asset Risk - Fixed Income

Only RBC amount is for cash working balance, £3 million at 0.3% = 9,000.

(average 9,000)

R2 Asset Risk - Equity

Not applicable

R3 Asset Risk - Credit

Outstanding reinsurance recoveries £5.7 million at 10% =	570,000
Unpaid reinsurances - nil	
	570,000
50%	285,000

(average 103,000)

R4 Underwriting Risk - Reserves

Gross outstanding loss reserves 19,233,000 at 18.3% =	3,523,000
50% of credit RBC	285,000
	3,808,000

((1,275*0.928) - 1 = 0.1832)

(average 2,553,000)

R5 Underwriting Risk - Net Written Premium

93,160,000 at 17.4% = 16,192,000

((0.917*0.942)+ 0.31 - 1 = 0.1738)

(average 16,176,000)

RBC (Company Action Level) = R0+SQRT(R1^2+R2^2+R3^2+R4^2+R5^2)

= SQRT(9000^2+285000^2+3808000^2+16192000^2)

=16,636,000

(average 16,414,000)